TAIL RAIL

BACKGROUND OF THE INVENTION

1. Field of the invention.

The present invention relates to the production of a material web, and, more particularly, to a method and a device for threading a material web.

2. Description of the related art.

During startup or after a web break, it is known to thread a material web into a machine for the production of the material web. For example, a peeling or lifting nozzle (or separating blow pipe) can be used in a paper-making machine in order to peel off an edge strip (or "tail") of the paper web produced, such as from a press roll or a drying cylinder. A transfer device or a so-called mini-doctor can be used to transfer the edge strip to a following section of the paper machine. Generally, in a first step, only the edge strip (or"tail") of the web is threaded into the machine, whereafter the edge strip is widened to the full width of the web. However, in some instances, threading of the full width web is also possible.

U.S. Patent No. 4,648,942 describes a paper machine including a pair of endless ropes which transport the tail from a receiving area (e.g. between a first and second cylinder of a drying section), for threading a paper web into the drying section of the paper machine. U.S. Patent No. 5,987,777 discloses a "rope-less" threading method which uses a plurality of air jets to transfer the tail through at least one section of a paper machine. A suction belt is disclosed by U.S. Patent No. 6,387,220 which can be used to transfer the tail across a distance.

The aforementioned known methods have been practiced more or less successfully. However, the operating speed of a modern paper making or processing machine is increasing into the range of 2000 to 2400 m/min. The known threading methods no longer operate in reliable and satisfying manner at these operating speeds.

In a more recent development, U.S. Patent No. 6,425,513 describes a device for transferring a threading strip and/or material web from a pick-up area into a transfer area along a web travel path for the production and/or processing of the web. The device includes a carrier for moving the strip and/or web along the web travel path through the machine at a carrier speed. The device also includes at least one pick-up unit for transferring the strip and/or web from the pick-up area to the transfer area at a relocation speed that is lower than the carrier speed. This device has the disadvantage of being relatively complex.

What is needed in the art is a threading method and device which: a) is suitable for modern paper making or processing machines and which can work at the high operating speeds and on all paper grades, b) has increased efficiency and reliability compared to known methods with a corresponding decrease in complexity, c) is designed to operate with relative ease and with low maintenance requirements, requiring fewer high-skilled operators and/or less skilled operators, and d) is capable of being retrofitted into existing machines without significant modification of the machine being modified.

SUMMARY OF THE INVENTION

The present invention provides a transporter with a clamp, and operating via a linear motor on a machine running path, to thread the tail and/or web.

The invention comprises, in one form thereof, an apparatus for threading a material web along a running path, comprising a linear motor having an electromagnetic rail extending at least partially along the running path and a transporter adapted to travel along the electromagnetic rail. The transporter includes at least one magnet. A clamp is connected to the transporter; the clamp is both movable and clampable with respect to the material web.

An advantage of the present invention is that it is suitable for modern paper making or processing machines and it works at the high operating speeds and on all paper grades.

Another advantage of the present invention is the increased efficiency and reliability compared to known methods with a corresponding decrease in complexity.

Yet another advantage is a design that operates with relative ease and with low maintenance requirements, requiring fewer high-skilled operators and/or less skilled operators.

A further advantage of the present invention is the capability of being retrofit into existing machines without significant modification of the machine being modified.

A yet further advantage is the tail rail of the present invention has minimal moving elements, namely the transporter and clamp, allowing for increased reliability.

Another advantage is the electromagnetic rail of the present invention can be fixedly supported by the machine frames and can extend along a plurality of machine sections, with the travel speed of the transporter variable during its travel through the various machine sections according to the different machine speeds.

Another advantage is conventional threading elements, e.g. ropes, rope sheaves, rope tensioners, air jets, vacuum belts, etc. are unnecessary.

Another advantage is the present invention provides a higher reliability in the threading operation so that machine downtime after a web break is minimized.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a schematic side view of a machine section including an embodiment of the tail rail of the present invention;

Fig. 2 is a cross-sectional view of the system of Fig. 1 taken along section line 2-2 showing an embodiment of the tail rail of the present invention in an unclamped position;

Fig. 3 is a cross-sectional view of the system of Fig. 1 taken along section line 3-3 showing an embodiment of the tail rail of the present invention in a clamped position;

Fig. 4 is a side view of the system of Fig. 2 as viewed from line 4-4;

Fig. 5 is a cross-sectional view of the system of Fig. 1 taken along section line 3-3 showing an alternative embodiment of the tail rail of the present invention using repulsive magnetization for levitation and/or propulsion; and

Fig. 6 is a cross-sectional view of the system of Fig. 1 taken along section line 3-3 showing an alternative embodiment of the tail rail of the present invention using attractive magnetization for levitation and/or propulsion.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate one preferred embodiment of the invention, in one form, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, and more particularly to Fig. 1, there is shown a final group 10 of a paper making machine which generally includes a last cylinder 12 of a dryer section, gripping area 14, calender 16, web running path 18, reel 20 of delivery area 22 and tail rail threading apparatus 24. Tail, edge strip or web 26 runs along web running path 18.

Although Fig. 1 shows a specific embodiment of a paper making machine, the present invention is not limited to use with these machine elements. Threading apparatus 24 can be used from a preceding section to a succeeding section of a papermaking machine. For example, the present invention can be used on a dryer section between a first and second dryer cylinder

through the entire dryer section and/or from the last cylinders of a press section to the first cylinder of a dryer section, but is not limited to these application examples. Threading apparatus 24 can be used with a machine for producing or processing a material web, wherein the machine includes at least one moving surface, such as dryer fabric 68, for both carrying and defining a running path of the material web. The at least one moving surface can be at least one of a belt, felt, wire, fabric, cylinder and/or roll. Material web 26 can be a fiber web in a papermaking machine. In general, the present invention can be used where threading is appropriate, with the aforementioned advantages over the prior art.

Threading apparatus 24 includes linear motor 28 with electromagnetic rail 30 which extends a section of web running path 18. Linear motor 28 also includes a cart or transporter 32 with magnet 34, which may be a permanent magnet or an electromagnet or a combination thereof. Clamp 36 is connected to transporter 32.

Alternatively, linear motor 28 can be a rotational motor, electromagnetic rail 30 can be a guide or a tube connected to the rotational motor, or a guide or a tube with a cable connected to the rotational motor and transporter 32.

Electromagnetic rail 30 includes a plurality of electromagnets 38 (Fig. 2) which extend sequentially along electromagnetic rail 30. Alternatively, electromagnetic rail 30 can include a plurality of permanent magnets or a combination of electromagnets and permanent magnets. A plurality of supports 40 are connected to electromagnetic rail 30 to fix its path. Support 40 can be connected, at one end, to a suitable structure 42, which can be a machine frame, and at the other end to rail beam 46. Rail beam 46 can be a continuous beam or can include a plurality of straight and curved sections. Electromagnets 38 can be momentarily and sequentially energized, with the speed of the sequential energization ranging up to the machine speed or beyond. Electromagnetic rail 30 can be installed between the front faces of the machine's rolls or

cylinders on either or both of the machine's drive side and tending side. Further, threading apparatus 24 can be installed, if needed, in addition to an existing conventional threading device (not shown).

Transporter 32 is adapted to travel along electromagnetic rail 30. Transporter 32 can include frame 48 to which wheels 50 are connected via axles 52, and which wheels 50 cooperate with at least one guiding face 51 of electromagnetic rail 30. Some of wheels 50 can be provided for safety and/or to support during standstill. Alternatively, transporter 32 can be guided by levitation magnet pairs 54 as shown in Fig. 5 (repulsive) or Fig. 6 (attractive), which can also be used for propulsion. Magnet 48 is connected to frame 48. As electromagnets 38 are momentarily and sequentially energized they create a propulsive force acting on magnet 34 resulting in a traveling speed which can range up to and beyond the machine speed. Transporter 32 can be relatively small in the direction of web running path 18 (about 100 mm to 200 mm, but not limited by this range), or can be subdivided into at least two sections (not shown) so that transporter 32 can traverse the electromagnetic rail's curved portions (e.g. at the periphery of rolls or cylinders).

Clamp 36 is supported by transporter 32 and includes a fixed flexible clamping element 56 and a pivotable flexible clamping element 58 which together hold tail, edge strip or web 26 therebetween during a threading operation. Alternatively, clamp 36 can include an adhesive strip at 56 which eliminates the need for pivotable flexible clamping element 58. At least one resilient member 60 and roll 62 act together and are actuatable to hold tail, edge strip or web 26 respective to transporter 32 during a threading operation as shown in Fig. 3, or to hold pivotable flexible clamping element 58 in an inoperable position as shown in Fig. 2. Pivotable flexible clamping element 58 rotates about pivot 64. Clamp 36 is adapted to grip tail, edge strip or web 26 in gripping area 14 and deliver the same to delivery area 22 so that transporter 32 transfers

tail, edge strip or web 26 along web running path 18 from gripping area 14 to delivery area 22. The transfer operation can occur at close to or equal to machine speed, and can inherently range from 0 m/min. to 2400 m/min. and beyond. As shown in Fig. 4, when transporter 32 enters gripping area 14, roll 62 meshes with stationary wedge 66, which pivots pivotable flexible clamping element 58 into a clamped position as shown in Fig. 3. An oppositely rotated stationary wedge (not shown) can be positioned in delivery area 22 to released clamp 36 to the position shown in Fig. 2, and thereby release tail, edge strip or web 26.

Clamp 36 can extend into the area of the width of web 26. Fixed flexible clamping element 56 and a pivotable flexible clamping element 58 are thin and flexible clamping elements which are adapted to be temporarily distorted when entering or leaving a curved portion of electromagnetic rail 30. Clamp 36 can include a knife or a weakening edge (both not shown) to sever the tail, thus forming a new beginning of the tail.

Threading apparatus 24 is compatible with machine sections wherein tail, edge strip or web 26 is supported by a wire, felt or fabric, such as dryer fabric 68. A clamped tail, edge strip or web 26 can be run through a wire, felt or fabric nip, or combination thereof, using threading apparatus 24.

The speed of the sequential energization of the electromagnetic rail 30 can be uniform or can be variable along web running path 18 as dictated by speed and position controls 70, which can control the sequential energization of electromagnetic rail 30. The variable speed can be helpful if electromagnetic rail 30 extends across two or more machine sections which are operating at different speeds, which in this case, electromagnetic rail 30 can bridge at least one partition place (not shown) between the two machine sections.

Electromagnetic rail 30 can include return section 72 guiding transporter 32 from delivery area 22 to gripping area 14, with electromagnetic rail 30 forming an endless loop as

shown in Fig. 1. Return section 72 can include parking area 74, which can be deactivated, wherein at least one transporter 32 can be parked waiting for the next threading operation.

Threading apparatus 24 can include launching mechanism 76 which can be used to start a threading operation. Launching mechanism 76 accelerates transporter 32 and pushes transporter 32 from parking area 74 into an active portion of electromagnetic rail 30 during the simultaneous sequential energization of electromagnetic rail 30. Launching mechanism 76 can be operated via spring load, pneumatic operation, hydraulic operation and the like. Launching control 77 can be used to actuate launching mechanism 76.

Parking area 74 can include at least one bypass portion 78. At least one cleaning cart 80 can be pushed from bypass portion 78 onto electromagnetic rail 30 in order to clean the same.

A threading apparatus for threading a full width web into a machine can include two electromagnetic rails 30, similar to previously described, one arranged at each machine side, and each electromagnetic rail 30 guiding one transporter 32, also similar to previously described.

Linear motor 28 can be in the form of a linear induction motor, linear synchronous motor, romag motor, claw-pole motor, homopolar inductor motor, heteropolor inductor motor, traklec motor and the like. Three phase alternating power can be the basis of operation with the frequency of phase change determining the speed of transporter 32. A variable frequency inverter can be used to vary the frequency of the power.

Alternatively, transporter 32 can include at least one electromagnet with or without magnet 34, and electromagnetic rail 30 can include at least one permanent magnet, with or without electromagnets. Therefore, electromagnetic rail 30 can be either energized or passive, as can transporter 32. Superconducting materials can be used in linear motor 28.

Using the fundamental principles of eletromagnetism, electromagnets or magnets in front of transporter 32 and on electromagnetic rail 30 are energized to attract transporter 32 while

electromagnets or magnets in front of transporter 32 and on electromagnetic rail 30 are energized to repel transporter 32. Alternatively, motivation of transporter 32 can work with only attractive or repulsive force. Other energization sequences are possible based on the specific form of linear motor 28.

In use, threading apparatus 24 grips tail, edge strip or material web 26 with clamp 36 connected to transporter 32, transporter 32 including at least one magnet. Transporter 32 and one of a tail, an edge strip or material web 26 move along electromagnetic rail 30 extending at least partially along web running path 18. Transporter 32 and electromagnetic rail 30 comprise linear motor 28. Tail, edge strip or material web 26 is transferred delivery area 22. Both the gripping operation and the transferring operation can include roll 62 meshing with stationary wedge 66. Transporter 32 can be launched from parking area 74 by launching mechanism 76 if needed to quickly attain machine speed. Motivation of transporter 32 with tail 26 can include sequential energization of electromagnetic rail 30.

While this invention has been described as having a preferred design, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.